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Retain Stringency and Enforceability of Residential Lighting Standards

Additional submitted attachment is included below.

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June 21, 2021

California Energy Commission
Docket Unit, MS-4
Docket No. 21-BSTD-01
1516 Ninth Street
Sacramento, California 95814-5512
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Re: 21-BSTD-01 2022 Energy Code Update Rulemaking

Recommendation to reverse the changes to Sections 150.0(k)1B, 160.5(a)1B and Tables 150,0-A and 160.5-and support quality residential lighting

The introduction of Joint Appendix JA8 "Qualification Requirements for High Luminous Efficacy Light Sources," in the 2016 version of Title 24, part 6 has had a significant impact on the quality, durability and safety of lighting installed in new residential construction. These requirements were built on the requirements and test methods of the ENERGY STAR program and expanded to enhance lighting quality and quantify the pre-existing flicker requirements that existed in Title 24, part 6 since 1992. The testing, listing in the MAEDBS JA8 database and labelling JA8 compliant products provide a low-cost, simple to enforce approach for assuring LED light sources are high efficacy, high color quality, low noise and low flicker.

The success of the Joint Appendix JA8 approach towards building a market of high-quality light sources is reflected in the over 62,000 lights sources in the JA8 database including 4,900 lamps. Lighting specifiers not only have a huge range of sources to choose from (including installing a JA8 compliant lamp in a screw-based luminaire), but they also have access to information about product life and flicker that have rarely been available before for residential luminaires.

Additionally, the unambiguous formant of the 2019 JA8 standards renders the requirements simple to enforce; all indoor LED fixtures must have the "JA8" label to be compliant. The building official does not need to dig through a database of light sources to confirm whether the LED light source is compliant with the California energy codes, they need only look for the "JA8" label on the light source.

The proposed 45-day express terms changes to Section 150.0(k)1B, Table 150.0-A and their counterparts in the new multifamily Section 160.5 would eliminate the JA8 requirements for most light sources in the JA8 database. Additionally, exempting some of the LED source categories would undermine the simplicity of residential lighting enforcement by creating ambiguity around which LED light source need labels and which one's do not. I recommend that CEC staff interview people who are involved with assuring compliance with the residential standards their thoughts on the proposal require labels and the quality specification on only a subset of LED lighting products.

Besides the legacy products (pin based fluorescent and CFLs, HID, hardwired induction) already exempted from JA8 compliance in Table 150.0-A, the changes would exempt all of the following light sources:

- All inseparable solid state lighting (LED and OLED) luminaires (not just those with colored light sources incapable of producing white light)

- Dim to warm LED
- Color tunable LED
- Title 20 compliant general service LED lamps (omnidirectional A lamps, most standard LED reflector lamps such as PAR 20 and PAR 38)
- Title 20 compliant fan light kits

As shown in Figure 1, the exceptions for inseparable solid state lighting sources and general service LED lamps would reduce the number of JA8 covered models to only 4.9% of models currently in the JA8 database. Some fraction of the remaining 4.9% LED sources (small diameter directional lighting, decorative lights, light engines and strip lights) would also be exempted for having color tuning or dim to warm controls.

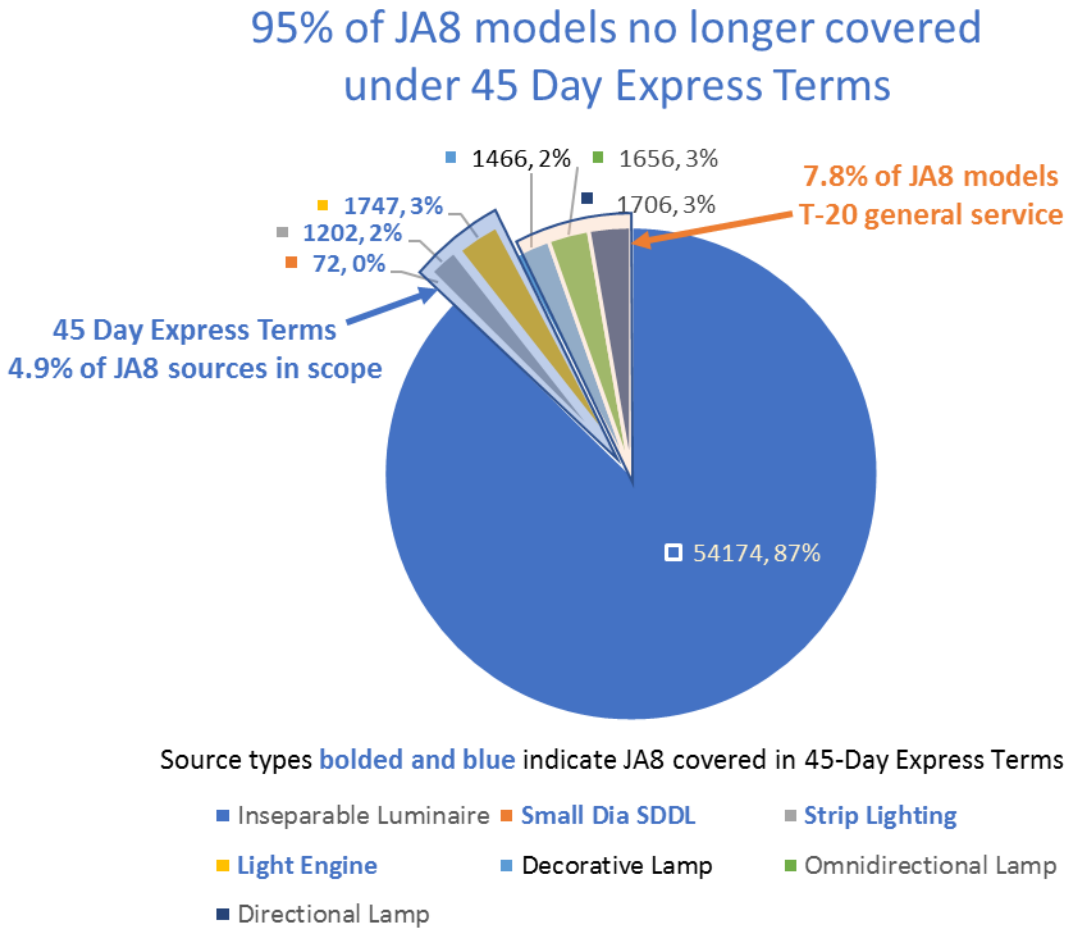


Figure 1: JA8 MAEDBS database: Number of Unique Models by Light Source Type

The ease of enforcing the current JA8 requirements result from their simplicity: every indoor LED that is capable of producing white light shall have the JA8 label. Under the proposed changes, this simple enforcement rule will be no longer valid; only 4.9% of the number of models in the current JA8 database would be required to have the JA8 mark.

Around 8% of the lamp models in the JA8 database might be considered a Title 20 general service lamp. However, not all ornamental lamps and not all reflector lamps are considered general service. With only 3,300 general service lamps models out of the 62,000 light source

models in the JA8 database, one might think that relaxing the general service lamp requirements would not have much impact. However, the number of lamps sold per model number are much greater than the number of integral fixtures sold per model. Thus, relaxing the lighting quality and flicker requirements on Title 20 lamps has a disproportionately large impact on the new homes and dwelling units built in California.

It is confusing for the lay person or even a building official to know what is a Title 20 general service lamp: "A" lamps are general service, but some reflector lamps are too; PAR 20's are included but not short neck PAR 20's, some globe lights are included but not ones less than 1.5" or greater than 5" diameter. Training and enforcement on differentiating which lamps must have the "JA8" marker versus those that are exempted is not straightforward.

All lamps sold in California are supposed to comply with Title 20, but there is no "Title 20" mark on the lamp. If the 45-day Express Terms are adopted, residential lighting code enforcement will no longer be as easy. With there be a requirement for HERS raters to compare lamp models against the Title 20 database? What is the mechanism for enforcement under the proposed change? The features of a JA8 lamp and Title 20 general service lamp are compared in the table below.

Table 1: Comparison of requirements for Title 24 JA8 and Title 20 General Service LED lamps

Criteria	**2019 Title 24 JA8 Lamp**	**Title 20 General Service Lamp**
Scope	Residential new construction	All lamps sold in California
LED Lamp Types	All	A lamps. Reflector (R) lamps, but not MR lamps and not short R20 lamps, and not less than 2 inch dia and not those without Edison screw bases, Candelabra (B, CA| &F), G (globe) lamps except ≥ 5" dia or ≤ 1.56",
Marking	"JA8-2022" or "JA8-2022-E" (elevated temperature)	Manufacturer, model, date manufacturer
Efficacy (lm/W)	Value > 45 lm/W	Value, Greater than compliance score
Dimming required	Yes	No
Dimming %	Value, ≤ 10%	Only if dimming Value, ≤ 10%
Flicker	Value, Full and at 20% in accordance with JA10	Only if dimming, No value, Pass/Fail at Full and 20% output
CRI	Value > 90	Value, > 82
R9 (red), color score	Value, > 0	No
R1-8 color score	No	Values, all ≥ 72
Power factor	Value, ≥ 0.9	Value, ≥ 0.7
Start time	Value, ≤ 0.5 sec	Voluntary Value, no criteria
Correlated Color Temperature (CCT)	Value, ≤ 4000 Kelvin	Value
Noise, dB	Value, ≤24 dBA	Dimming only, Value, ≤24 dBA
Lumen maintenance	3,000 hour value, > 93.1%	Voluntary 6,000 hour, no criteria
Survival rate	3,000 hour value, > 90%	Voluntary 6,000 hour, no criteria

Besides the difficulty of enforcing the Title 20 standard during site inspection, what is being proposed is less protective of California's citizens. As a standard that applies to all lamps sold, the Title 20 standard does not have the same level of stringency as standard that only applies to

permitted residential construction. Most of the sockets in new construction have either dimmers or occupancy sensors. The Title 20 standard does not require that lamps be dimmable. Placing non-dimmable lamps in sockets controlled by a dimmer can impact the longevity of the lamp, and sometimes the house if the lamp catches fire.

Though both JA8 and Title 20 requires testing in regards to whether lamps can last under elevated temperatures conditions in enclosed or recessed fixtures, only JA8 requires that the lamp be labelled "JA8-2022-E" to indicate that it is compatible with enclosed or recessed luminaires.

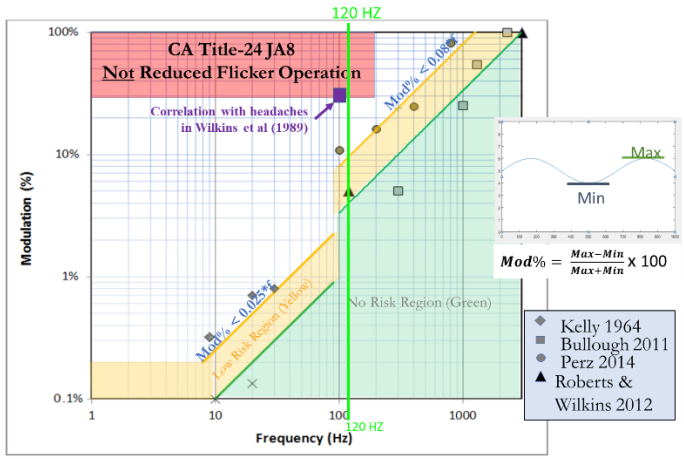


Figure 2: IEEE 1789-2015 "Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers."

Though static (non-dimmable) LED lamps can just as easily flicker as dimmable lamps, the Title 20 standard only requires that dimming lamps need be tested for flicker. Non-dimming lamps regulated under Title 20 are not required to be tested for flicker. This is perhaps due to a misconception that flicker is mainly a function of dimming. This is not the case, lamps without dimmers also flicker.

There have also been recommendations to not only exempt Title 20 regulated general service LED lamps but all Title 20 regulated LED lamps. The other Title 20 regulated lamps have even less quality requirements, there is no minimum color rendition of flicker requirements for these lamps.

As I mentioned in my comments to the EIR docket, [1] though the "reduced flicker operation" (< 30% amplitude modulation for frequencies less than 200 Hz) requirement in JA8 and T-20 (for dimming lamps) has eliminated some of the worst performing light sources in terms of flicker, but minimal compliance with this standard is still 300% higher than the recommended amplitude modulation (percent flicker) for the primary frequency of interest (120 Hz; see the green line on figure 2). Thus it is highly desirable that specifiers, consumers and regulators such as the Energy Commission, the California Department of Public Health and Cal OSHA have access to this information.

During the development of the 2016 Title 24 standards including JA8, the Statewide CASE team had tested omnidirectional lamps for flicker and found that approximately one half would not pass the relatively weak "reduced flicker operation" requirement that is in JA8 and in Title 20, but only for dimming lamps. An additional study found that LEDs have a broad range of flicker performance from very low flicker (less than incandescent) to extremely high flicker (as high as

[1] See comments to EIR docket:
https://efiling.energy.ca.gov/GetDocument.aspx?tn=237497&DocumentContentId=70695

100% amplitude modulation) and that about half of these other types of lamps also would fail the criteria for "reduced flicker operation."[2]

The data below from the JA8 database indicates there is a critical mass of lamps that would meet the IEEE 1789 standard but that there are still many lamps just below the 30% maximum flicker level that have flicker levels similar to magnetically ballasts fluorescents that were correlated with headaches.

I am not aware that the market is transformed there is likely many LED sources that exceed the "reduced flicker operation" requirements. No other standard, not EnergyStar, not WELL, not LEED are making flicker information available to specifiers and none of these standards limit flicker. California has been a leading light on this front, but instead of taking the next step to align with the ANSI/IEEE standard on flicker, the 45-day language proposes to stop collecting flicker data on this key indicator of health risk in JA8 and not regulating flicker for non-dimmable general service lamps as well as any of the other LED light sources under consideration for placing in the left column of Table 150.0-A and 160.5-A.

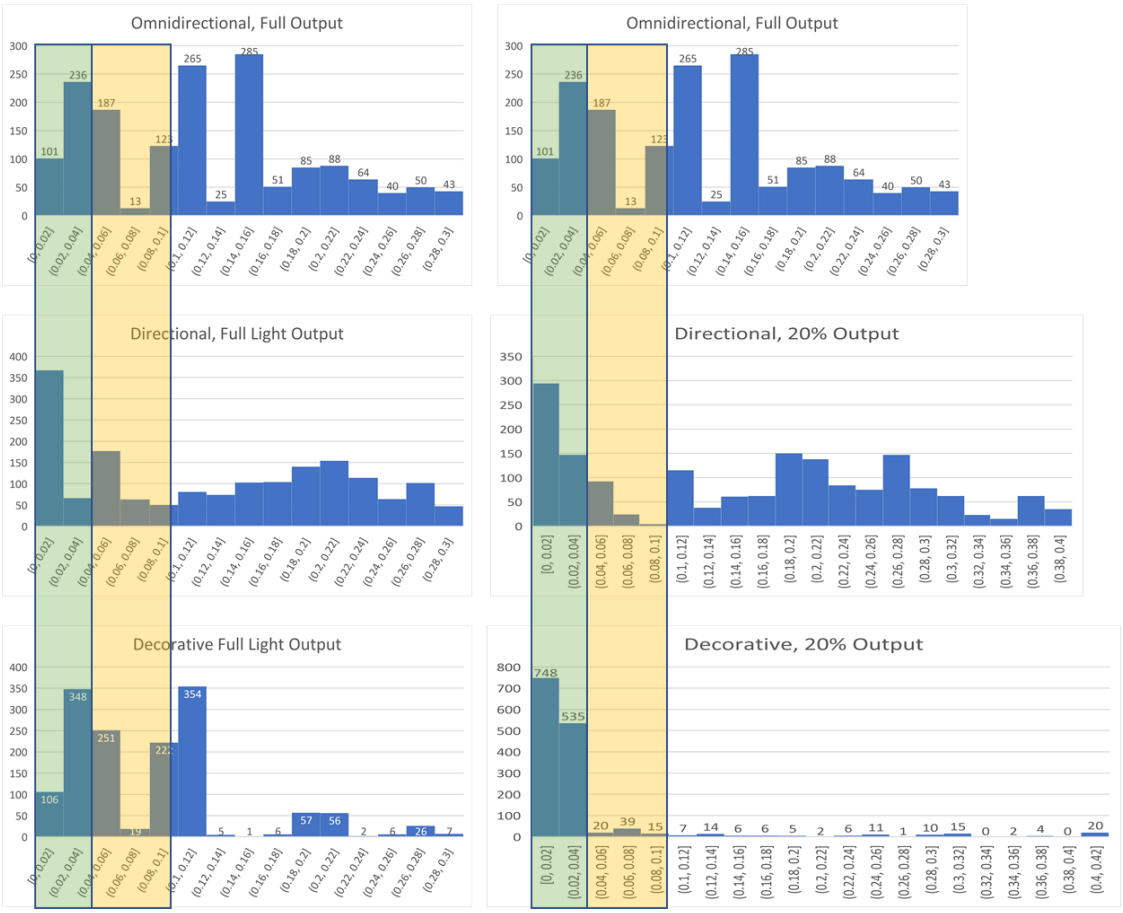


Figure 3: JA8 flicker data (cut-off frequency 200 Hz) for T-20 general service lamps, with green overlay for IEEE-1789 "no risk" and yellow overlay for "low risk" regions

[2] See J. McHugh & M. McGaraghan. *Quantifying Flicker: Fourier Filtering of Light*. 2016 IES Conference https://www.mchughenergy.com/papers/McHugh-QuantifyingFlicker_2016IES_ConfPaper-v4.pdf

The above information for Title 20 lamps (or any other source that is exempted from JA8) would be not accessible for the quickly changing market if the 45 Day Express terms does not reverse course of weakening the consumer protections for residential lighting and return to the 2019 Table 150.0-A requirements for JA8 coverage.

It is reasonable to expect that the outcome is less code compliance and more light sources being installed in homes that fail prematurely, flicker, or have other objectionable characteristics. In some cases, this results in the light source being replaced with a light source outside of the scope of the building standards as a repair or replacement after the certificate of occupancy has been granted. In other cases, it results in Californians putting up with light sources that may risk health or productivity.[3]

There is also a misconception that dim to warm or color tuning light sourced have advanced ballasts and thus will necessarily be low flicker. NEMA's Next Generation Lighting Industry Alliance publication *"Dim to Warm LED Lighting: Initial Benchmarks,"* provided color rendering and flicker information for 4 prototypical dim to warm lamps. Lamp C had percent flicker above 40% at full output and during all dimming tests and this would not comply with Joint Appendix JA8. Lamp A when dimmed to 50% of light has a percent flicker of 29.7% it barely passes the minimal "reduced flicker operation" requirement. The other two lamps did much better. Under a proposed 45-day standard that exempts all dim to warm lamps, the specifier would not know which lamps perform better and the manufacturer of dim to warm light sources with low flicker performance would not receive any deserved credit or market awareness for their low flicker product.

The initial statement of reasons had this to say about the necessity for making the changes to Tables 150.0-A.

New generation of light source technologies for residential building lighting applications have been considered for their relevancy and physical characters. These changes are also necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions reflects and aligns, where feasible, with the development of lighting technologies and the products as available to the building sector marketplace. Further, the changes are necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Does the intent of *"aligns with aligns, where feasible, with the development of lighting technologies and the products as available to the building sector marketplace,"* mean that all LED products on the market are high quality and low flicker and therefore, quality requirements and their disclosure is no longer needed? If so I don't think the ISOR or data presented so far has supported this assertion. The data I have provided above indicates that there are products that do not comply with the Title 24 standards and of those that do comply there is a wide range of performance. I think that continuing to publish lighting system performance is something that matches the intent to *"reflect and align …with development of lighting technologies."* It is by disclosing tested product performance that drives competition for better products that are both energy efficient and that mitigate potential health risk.

[3] Ibid

Recommendations

I recommend that the Commission reverse course on dismantling the lighting quality specification as implemented through enforcement of JA8 for all indoor LEDs that are capable of producing white light. To do this I recommend reinstating the requirements of the 2019 version of Title 24, part 6 in table 150.0-A by making the following changes to the 45-day Express Terms in developing the 15-day Express Terms for 2022 Energy Code:

- Table 150.0-A *Classification of High Luminous Efficacy Light Sources*, revert the requirements back to as they were in the 2019 standards. Adding the term "luminous" before efficacy does not change the intent.
- Table 160.5-A *Classification of Dwelling High Luminous Efficacy Light Sources*, match the requirements to Table 150.0-A after they have been reverted back to as they were in the 2019 standards.
- Section 150.0(k)1B, remove list of lamps that are treated as an alternative to JA8 compliance in screw-based luminaires. Strike from requirements *"or contain lamps as specified in Table 150.0-A including qualified colored lamps, dim-to-warm lamps, tunable-white lamps, color-tunable lamps, and Title 20-compliant LED lamps."*
- Section 160.5(a)1B. remove list of lamps that are treated as an alternative to JA8 compliance in screw-based luminaires. Strike from requirements *"or contain lamps as specified in Table 150.0-A including qualified colored lamps, dim-to-warm lamps, tunable-white lamps, color-tunable lamps, and Title 20-compliant LED lamps."*

My suggested proposed changes to the 45-day Express Terms are shown below in red font with double strikethrough and double underline (single black underline are the 45 day proposed additions and ~~single black strikeout~~ the 45 day proposed deletions that I am not proposing to be changed, and ~~red font with single underline but double strikethrough~~ were 45 day added text that I recommending being struck.):

Edit Section 150.0(k)1B as follows:

(k) **Residential Lighting.**
1. **Luminaire Requirements.**
A. **Luminaire Efficacy.** All installed luminaires shall meet the requirements in TABLE 150.0-A.
EXCEPTION 1 to Section 150.0(k)1A: Integrated device lighting. Lighting integral to exhaust fans, kitchen range hoods, bath vanity mirrors, and garage door openers.
EXCEPTION 2 to Section 150.0(k)1A: Navigation lighting such as night lights, step lights, and path lights less than 5 watts.
EXCEPTION 3 to Section 150.0(k)1A: Cabinet Lighting. Lighting internal to drawers, cabinetry, and linen closets with an efficacy of 45 lumens per watt or greater.

B. **Screw based luminaires** ~~**Blank Electrical Boxes.**~~ Screw based luminaires shall contain lamps that comply with Reference Joint Appendix JA8 ~~or contain lamps as specified in Table 150.0-A including qualified colored lamps, dim-to-warm lamps, tunable-white lamps, color-tunable lamps, and Title 20-compliant LED lamps.~~ ~~The number of electrical boxes that are more than 5 feet above the finished floor and do not contain a luminaire or other device shall be no greater than the number of bedrooms. These electrical boxes must be served by a dimmer, vacancy sensor control, or fan speed control.~~

Edit Section 160.5(a)1B as follows:

SECTION 160.5 – MANDATORY LIGHTING REQUIREMENTS FOR INDOOR AND OUTDOOR SPACES

The design and installation of all lighting systems and equipment in multifamily buildings within the scope of Section 100.0(a) shall comply with the applicable provisions of Section 160.5. All functional areas except dwelling units and common living areas shall comply with the applicable requirements of Section 160.5(b) through 160.5(e).

(a) Dwelling Unit and Common Living Area Lighting.

The design and installation of all lighting systems and equipment in multifamily dwelling units and common living areas shall comply with Section 160.5(a). Multifamily dwelling units include dormitory and senior housing dwelling accommodations. Outdoor lighting attached to multifamily buildings and controlled from the inside of a dwelling unit shall comply with the lighting requirements of Section 160.5(a).

1. Luminaire Requirements.

A. Luminaire Efficacy. All installed luminaires shall meet the requirements in TABLE 160.5-A.

EXCEPTION 1 to Section 160.5(a)1A: Integrated device lighting: Lighting integral to exhaust fans, kitchen range hoods, bath vanity mirrors, and garage door openers, and non-removable lighting attached to ceiling fans.

EXCEPTION 2 to Section 160.5(a)1A: Navigation Lighting: Night lights, step lights, path lights less than 5 watts.

EXCEPTION 3 to Section 160.5(a)1A: Cabinet Lighting: Lighting internal to drawers, cabinetry, and linen closets with an efficacy of 45 lumens per watt or greater.

B. Screw based luminaires. Screw based luminaires shall contain lamps that comply with Reference Joint Appendix JA8 ~~or may contain lamps as specified in Table 150.0-A including qualified colored lamps, dim-to-warm lamps, tunable white lamps, color-tunable lamps, and Title 20-compliant LED lamps.~~

Edit Table 150.0-A to match what is currently in 2019 Title 24, part 6 as follows:

TABLE 150.0-A CLASSIFICATION OF HIGH LUMINOUS EFFICACY LIGHT SOURCES

Light sources in this column other than those installed in ceiling recessed downlight luminaires are classified as high luminous efficacy and are **not** required to comply with Reference Joint Appendix JA8	Light sources in this column are required to comply with Reference Joint Appendix JA8 and shall be certified and marked as required by JA8.
1. Pin-based linear fluorescent or compact fluorescent light sources using electronic ballasts. 2. Pulse-start metal halide light sources. 3. High pressure sodium light sources. 4. Luminaires with hardwired high frequency generator and induction lamp. 5. LED light sources installed outdoors.	7 ~~10~~. All light sources installed in ceiling recessed downlight luminaires ~~other than those specified in items 3, 4, or 5~~. Note that ceiling recessed downlight luminaires shall not have screw base sockets regardless of lamp type as specified in Section 150.0(k)1C. 8 ~~11~~. Any light source not otherwise listed in this table.

6. Inseparable SSL luminaires containing colored light sources that are installed to provide decorative lighting. ~~1. LED light sources installed outdoors.~~ ~~2. Inseparable Solid State Lighting (SSL) luminaires and colored light sources that are installed to provide decorative, accent, display, utility, undercabinet or special effect lighting.~~ ~~3. Dim-to-warm and tunable-white LED light sources with at least one light source controller setting of 4000K or less and color rendering index (CRI) rating of 90 or greater.~~ ~~4. Color-tunable LED light sources with at least one light source controller setting of 4000K or less.~~ ~~5. LED lamps compliant with Title 20 as general service lamps and with a correlated color temperature (CCT) of 4000K or less.~~ ~~6. Pin-based linear fluorescent or compact fluorescent light sources using electronic ballasts.~~ ~~7. High intensity discharge (HID) light sources including pulse start metal halide and high pressure sodium light sources.~~ ~~8. Luminaires with hardwired high frequency generator and induction lamp.~~ ~~9. Ceiling Fan Light Kits compliant with Title 20 requirements.~~	

Edit Table 160.5-A to match the requirements in Table 150.0-A in 2019 Title 24, part 6 as follows:

TABLE 160.5-A CLASSIFICATION OF DWELLING UNIT HIGH LUMINOUS EFFICACY LIGHT SOURCES

Light sources in this column other than those installed in ceiling recessed downlight luminaires are classified as high luminous efficacy and are **not** required to comply with Reference Joint Appendix JA8	Light sources in this column are required to comply with Reference Joint Appendix JA8 and shall be certified and marked as required by JA8.
1. Pin-based linear fluorescent or compact fluorescent light sources using electronic ballasts. 2. Pulse-start metal halide light sources. 3. High pressure sodium light sources. 4. Luminaires with hardwired high frequency generator and induction lamp.	7 ~~10~~. All light sources installed in ceiling recessed downlight luminaires ~~other than those specified in items 3, 4, or 5~~. Note that ceiling recessed downlight luminaires shall not have screw base sockets regardless of lamp type as specified in Section 150.0(k)1C.

5. LED light sources installed outdoors. 6. Inseparable SSL luminaires containing colored light sources that are installed to provide decorative lighting. ~~1. LED light sources installed outdoors.~~ ~~2. Inseparable Solid State Lighting (SSL) luminaires and colored light sources that are installed to provide decorative, accent, display, utility, undercabinet or special effect lighting.~~ ~~3. Dim-to-warm and tunable-white LED light sources with at least one light source controller setting of 4000K or less and color rendering index (CRI) rating of 90 or greater.~~ ~~4. Color-tunable LED light sources with at least one light source controller setting of 4000K or less.~~ ~~5. LED lamps compliant with Title 20 as general service lamps and with a correlated color temperature (CCT) of 4000K or less.~~ ~~6. Pin-based linear fluorescent or compact fluorescent light sources using electronic ballasts.~~ ~~7. High intensity discharge (HID) light sources including pulse start metal halide and high pressure sodium light sources.~~ ~~8. Luminaires with hardwired high frequency generator and induction lamp.~~ ~~9. Ceiling Fan Light Kits compliant with Title 20 requirements.~~	8 ~~11~~. Any light source not otherwise listed in this table.

Please consider the recommendations above. I am available to talk with CEC staff concerning these recommendations that I believe are in full alignment with the Warren Alquist Act and the other great improvements staff have made to the 2022 version of the Title 24, part 6 building energy efficiency code.

The roll-backs to the stringency of Tables 150.0-A and 160.5-A are not recommended. If anything the CEC should be considering harmonizing with the IEEE-1789 standard instead of dropping lighting quality requirements altogether for large classes of residential lighting luminaires.

Sincerely,

Jon McHugh, PE

Appendix A Background to JA8

Most of the updates to the 2022 Energy Code (Title 24, Part 6) have been carefully vetted through several stakeholder meetings and pre-rulemaking workshops, with multiple public opportunities to comment and suggest revisions. However, the changes to Section 150.0(k)1B, Table 150.0-A *Classification of High Luminous Efficacy Light Sources* have not benefitted from the same level of scrutiny. These changes newly exempt most LED light sources from the requirements of JA8 and were not discussed during earlier stakeholder or pre-rulemaking meetings. The changes appear publicly for the first time in the draft express terms and 45-day Express Terms and were mentioned briefly on one slide in the recent staff presentation.[4]

In contrast, during the 2016 Title 24, part 6 rulemaking, the costs, the savings and the rationale for the JA8 lighting quality requirements thoroughly vetted with detailed physical tests of lighting products, including the development of the JA10 flicker test method, public stakeholder meetings[5], the Energy Commission public process, and a detailed CASE code change proposal.[6]

The short synopsis of the rationale behind the JA8 LED quality specification is that prior efforts to replace incandescent lamps with compact fluorescents had stalled out. Additionally, in many cases, installed CFLs had be later on replaced with incandescents. Studies had indicated unhappiness with CFLs due to: noise, failure when installed on a dimmer, premature failure when installed in an enclosed or recessed fixtures, poor color quality (excessively high CCT and excessively low CRI) and flicker. Most of these quality issues except flicker were addressed by the ENERGY STAR program. Because of the history of replacing CFLs with incandescents, versions of Title 24, part 6 prior to 2013 did not allow screw-in lamps to be considered high efficiency. Those legacy sources (as are in the left side of the Table 150.0-A), could not be easily replaced and included luminaires with hardwired HID or fluorescent ballasts, and those with GU-24 bases for CFL and LED lamps.

The Joint Appendix JA8 test, list and label regime was developed so that the first lights in a new home would last, look good and not flicker so there would not be a motivation to replace a high efficacy lamp with an incandescent. By disclosing to the public (production builder purchasing agent), the information about these light sources would incentivize products to complete on energy efficiency and product quality as well as price.

Requirements for high quality lamps provided confidence that the LED source would remain in place so that screw base sockets could be considered high efficacy if there was a JA8 lamp in the socket. This allowed a massive expansion of what was a high efficacy fixtures outside of the hard-wired ballasted legacy fixtures. With this huge range of high efficacy products, this enabled the 2016 residential lighting standards to require that all lighting to be high efficacy. As described in the 2016 Residential Lighting CASE report, the energy savings of this approach was estimated to be 85 GWh/yr for each year's new construction.

Light sources that are certified and labelled as JA compliant have been tested for:

- Luminous efficacy – at least 45 lm/W
- Power factor at least 90%
- Start time no less than ½ a second

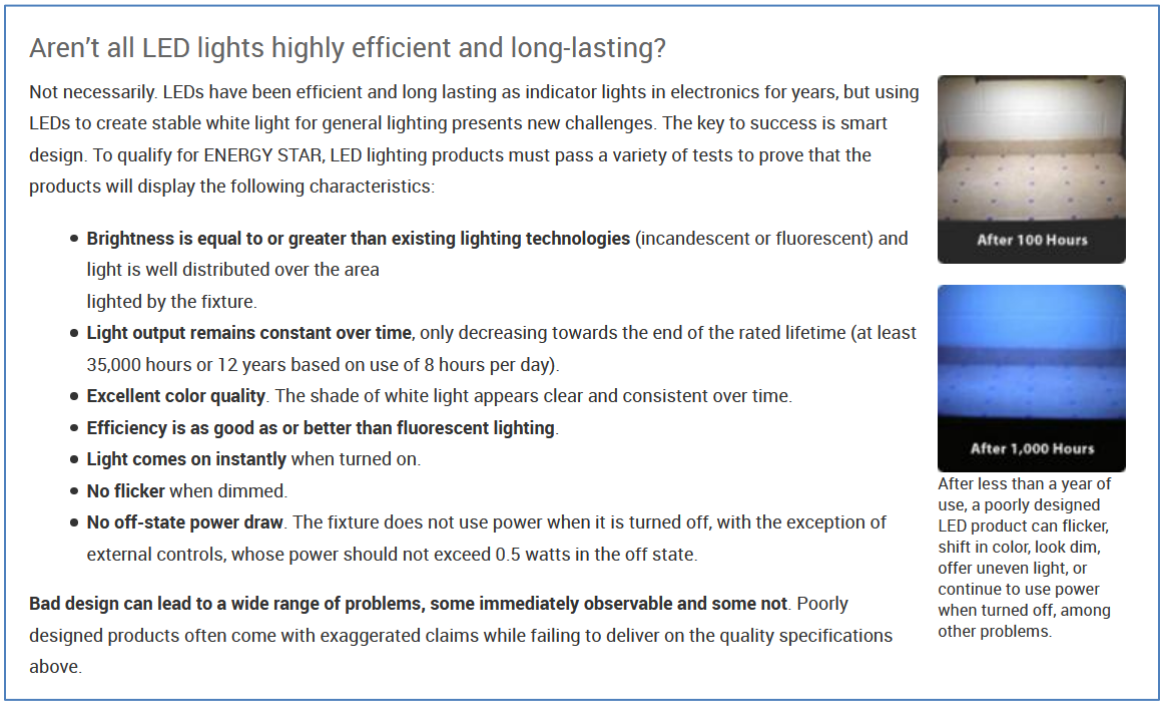
[4] Slide 15. *May 27, 2021. Staff Presentation at the Lead Commissioner Hearing* TN #: 238043 https://efiling.energy.ca.gov/GetDocument.aspx?tn=238043&DocumentContentId=71294

[5] https://cltc.ucdavis.edu/2016-title-24-leadership-support

[6] http://title24stakeholders.com/wp-content/uploads/2017/10/2016_CASE-Report_Residential-Lighting.pdf

- Color quality – color rendering index (CRI) no less than 90
- Color temperature – no greater than 4,000 Kelvin
- Longevity – at least 15,000 hours
- Dimmability
- Low flicker operation, less than 30% flicker for frequencies less than 200 Hz.
- Low audible noise – less than 24 dBA at 1 meter

Figure 4 is from the ENERGY STAR website. It indicates that the market contains a variety of LED sources, some are outstanding, but others have the problems listed below. ENERGY STAR and JA8 are designed to shield occupants of Title 24 compliant dwelling units from these problems.



Aren't all LED lights highly efficient and long-lasting?

Not necessarily. LEDs have been efficient and long lasting as indicator lights in electronics for years, but using LEDs to create stable white light for general lighting presents new challenges. The key to success is smart design. To qualify for ENERGY STAR, LED lighting products must pass a variety of tests to prove that the products will display the following characteristics:

- **Brightness is equal to or greater than existing lighting technologies** (incandescent or fluorescent) and light is well distributed over the area lighted by the fixture.
- **Light output remains constant over time**, only decreasing towards the end of the rated lifetime (at least 35,000 hours or 12 years based on use of 8 hours per day).
- **Excellent color quality**. The shade of white light appears clear and consistent over time.
- **Efficiency is as good as or better than fluorescent lighting**.
- **Light comes on instantly** when turned on.
- **No flicker** when dimmed.
- **No off-state power draw**. The fixture does not use power when it is turned off, with the exception of external controls, whose power should not exceed 0.5 watts in the off state.

Bad design can lead to a wide range of problems, some immediately observable and some not. Poorly designed products often come with exaggerated claims while failing to deliver on the quality specifications above.

After less than a year of use, a poorly designed LED product can flicker, shift in color, look dim, offer uneven light, or continue to use power when turned off, among other problems.

Figure 4: ENERGY STAR Aren't all LEDs highly efficient and long lasting?[7]

On difference between the ENERGY STAR rating and that of Title 24 JA8, is that ENERGY STAR qualified lamps and luminaires do not have criteria for maximum allowable flicker, nor do they publish the measured flicker.

Flicker (Light Modulation) and Its Impact on Human Health and Performance

Physiological flicker is amplitude modulation of light at frequencies that affects human physiology. Physiological flicker encompasses both perceptible flicker and imperceptible flicker. Perceptual flicker is flicker than can be consciously detected. Perceptual flicker includes both directly perceived flicker and indirectly perceived flicker. Directly perceived flicker takes place under relatively ideal conditions of little movement by 1) the observer 2) the eyes of the observer or 3) objects in the visual field.

7 https://www.energystar.gov/products/lighting_fans/light_fixtures/why_choose_energy_star_qualified_led_lighting

Imperceptible flicker is flicker that is not noticed but still has an impact on human physiology. Berman et al (1991) has documented with electroretinogram (ERG) measurements that there are physiological responses to modulating light sources well above the perceptual critical fusion frequency (CFF) *"…our results show that a measurable but gradually decreasing ERG signal is obtained from stimuli oscillating at rates up to 200 Hz."*

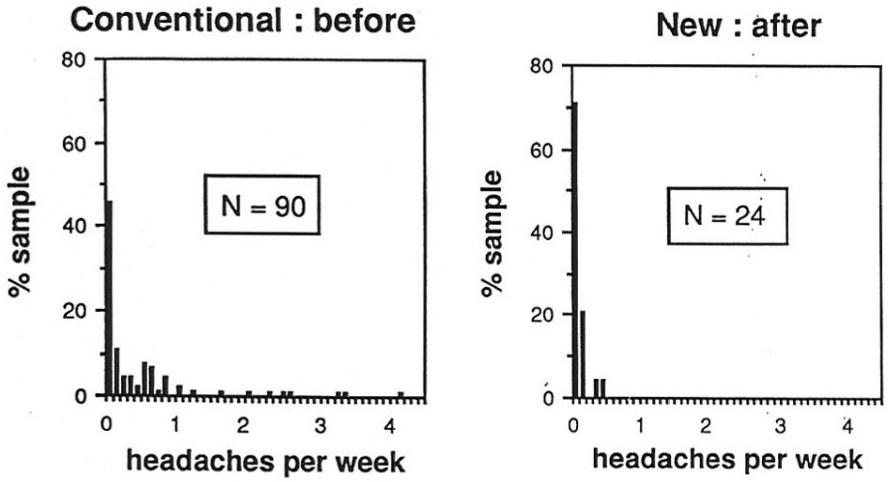


Figure 5: Number of Headaches with Magnetic (100 Hz) Ballasts vs Electronic

Studies on imperceptible flicker by Veitch (1995) and Wilkins et al (1989) found performance and headache effects from magnetically ballasted fluorescent lighting (with around 30% modulation depth at 120 Hz).[8] Wilkins reported that "headaches and eyestrain were reduced by a factor of two or more when the controlling circuitry was changed to the new high-frequency ballast and the light no longer fluctuated in intensity…" Wilkins also wrote that "as can be seen from a comparison of the histograms for new and conventional lighting …, the tail of the distributions is longer in the case of conventional lighting: a few subjects suffered headaches or eyestrain frequently and they did so mainly under conventional lighting." (Underline added for emphasis).

In the left-hand graph in Figure 2, seven people out of the 90 sampled had headaches more than 2 times per week and none of the subsample of 24 people who received electronic ballasts in the right hand graph have more than one headache a week. Conventional lighting here means magnetically ballasted fluorescent lighting. What is important about this finding is that a modest but significant population (8%?) of people is more sensitive to flicker. It implies that for broad acceptance and embrace of this technology we should be considering not just what avoids deleterious health effects for the average person but also for people who are more sensitive to flicker.

With the long life of LEDs and imperceptible flicker being correlated with headaches, it is important that while achieving the State's greenhouse reduction goals, that the state is retaining the protections that encourages the lighting market to continue to compete on lighting quality including low flicker lighting. For competitive markets there needs to be free access to information so that the consumer can be aware of features or benefits that are otherwise invisible.

[8] Wilkins, et al (1989) The measured percent flicker or percent amplitude modulation (AM) of magnetic ballasts in this study is between 27% and 33%. This was presented in terms of 43% to 50% of peak-to-trough (PT) modulation. The conversion is AM = PT/(2-PT).

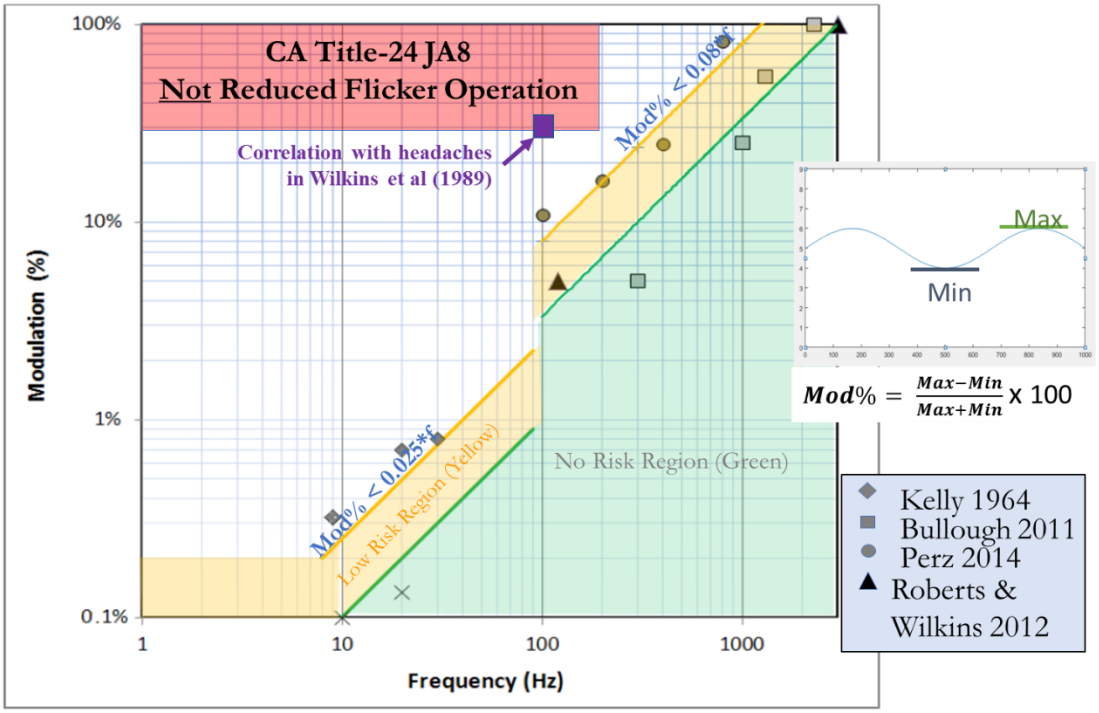


Figure 6: IEEE PAR 1789-2015 Low Risk and No Risk Regions

The Institute of Electrical and Electronics Engineers IEEE 1789-2015 Standard, "Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers." has helped the lighting industry understand that the effect of flicker on the human organism varies by both depth of modulation and frequency. This standard has synthesized the various studies that indicate that there are physiological impacts of modulating light associated with direct perception of flicker (including seizures for some people) but that there are also physiological impacts beyond the range of frequencies that are associated with direct perception of flicker. This is the only flicker standard that has undertaken the rigorous ANSI standard development process that not only includes public review but also requires that the committee membership is balanced among different interest groups.

A key outcome of this synthesis of the research to date was a recommendation document that included a two dimensional risk map of frequencies and modulation (%) as shown **Figure 6**, with three primary regions: 1) No Risk Region (Green) where there is little expectation of any physiological effect, also known as the "No Observable Effect Level" (NOEL). This is where physiological response so far is not measurable. 2) Low Risk Region (Yellow) where a physiological response is detected but the response is small and deemed to be unlikely to be damaging and 3) Not Low Risk Region (White) where there may be a range of risk from not much risk to the severe risk associated with triggering epileptic seizures or vertigo with relatively modest amplitude modulation at low frequencies.

Superimposed on the upper left-hand corner of this risk map is a red box labelled "CA Title 24 JA8 Not Low Flicker Operation." This box defines an area on the graph that is greater than 30% amplitude modulation for frequencies less than 200 Hz. By definition, this combination of amplitude modulation and frequency is non-compliant with the current definition of "low flicker operation." While researching the development of the JA10 test method, approximately half of LED lamps were performing worse and had amplitude modulation greater than 30% for

frequencies less than 200 Hz. These lamps would not comply with JA8. For reference, superimposed on this graph is a purple box which is representative of the range of amplitude modulation (27% to 33%) at 100 Hz. Note that this range straddles the bottom edge of the "not reduced flicker" area on the graph. Thus, a fluorescent lighting system that could marginally qualify in the JA8 (and Title 20) as having "reduced flicker operation" could have a lighting waveform similar to those correlated with headaches.

There is a gap in regulation between the CA JA8 excluded light sources and what IEEE 1789 designates as low risk. In the short term, this gap can be addressed through incentive programs and education of designers and specifiers as well as reach standards such as WELL, LEED, and the International Green Construction Code (IgCC). All these efforts to close the gaps between minimum code compliance and enhanced flicker protection require market information about the flicker performance of light sources such as is contained in the JA8 database.[9] This knowledge base is not just needed in the regulatory arena but also in the broader marketplace where advanced manufacturers and designers can provide low flicker lighting designs as part of high performance green design. It is within this context that I am concerned about removing requirements for "reduced flicker operation" and test and list requirements for color tunable and dim to warm sources and removing the test and list requirements for Title 20 covered general service LEDs.

With background in mind, removing the underlying structure to this significant residential energy efficiency portion of the energy code should be taken with great care. In considering removing the lighting quality test, list and labelling requirements, some key questions should be answered:

- Do the JA8 requirements decrease the amount of poor quality of lighting installed in new California residences?
- What portion of the JA8 requirements are most burdensome?
- What JA8 requirements are frequently failed? How important is it to prevent these quality failures from being installed in California homes?
- What aspect of the JA8 published data is being used to specify beyond minimum compliance?
- Does the Title 20 general service luminaire database provide a reliable method of checking flicker compliance with a Yes/No response rather than the numerical results of flicker tests as required by JA8?
- If a residential light source is replaced due to longevity or quality shortcomings, how likely is it that a lower efficacy light will replace it?
- Is there new health and human performance data that would indicate that the JA8 requirements be strengthened and not weakened?

[9] In the EIR docket, Jim Stewart has proposed that Title 24, Part 6 and Part 11 (CalGreen) test and label lights sources as IEEE 1789 compliant and eventually mandate this for all light sources. https://efiling.energy.ca.gov/GetDocument.aspx?tn=237519&DocumentContentId=70719

Appendix B: ISOR Comments

In the Initial Statement of Reasons (ISOR), Energy Commission staff indicated that the proposed change was needed for the following reasons:.[10]

Section:150.0(k)1B

Necessity:

These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section: Table 150.0-A

Necessity:

New generation of light source technologies for residential building lighting applications have been considered for their relevancy and physical characters. These changes are also necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions reflects and aligns, where feasible, with the development of lighting technologies and the products as available to the building sector marketplace. Further, the changes are necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Neither the ISOR, nor the information presented at the May 24th staff presentation, includes a clear discussion of how removing the JA8 light source quality requirements affects energy savings, and how it "reflects and aligns with the development of lighting products." Doesn't measuring and publishing both light quality (amenity) and energy efficiency of products in new construction align with improved lighting products that produce highly efficient lighting products without sacrificing lighting quality?

The ISOR is silent on these aspects of the staff proposal:

- What motivated the proposed changes to Table 150.0-A?
- What are the repercussions of removing test, list and marking requirements on lighting quality, product availability and code compliance?
- What alternatives were considered?

The JA8 test, list and label process has been a crucial underpinning to the "all high efficacy lighting" basis of the residential lighting standards. It is reasonable that these standards be revisited periodically. But given their impact on not just energy efficiency but also consumer protection, these should be carefully evaluated with opportunity for extensive public involvement. The ad hoc nature of these significant changes being proposed in the express terms without detailed analysis or public engagement is not appropriate. I recommend that these proposed changes do not proceed, and that this topic be researched for the next code cycle with all options on the table including consideration of updating the flicker standards to be based on ANSI/IEEE Standard 1789-2015.

[10] Page 100, 103 and 104 TN #: 237716, *Initial Statement of Reasons 2022 Energy Code Proposed Changes*, https://efiling.energy.ca.gov/GetDocument.aspx?tn=237716&DocumentContentId=70938